Design and Implementation of Wireless Brainwave Stimulated Accident Prevention System

Mr. Gummarekula Sattibabu
Assistant Professor,
Department of ECE,
Regency Institute of Technology,
Yanam, UT of Puducherry, India

Mr. B.V.V. Satyanarayana
Assistant Professor,
Department of ECE,
Regency Institute of Technology,
Yanam, UT of Puducherry, India

Mr. V.V Satyanarayana Kona
Assistant Professor,
Department of ECE,
Regency Institute of Technology,
Yanam, UT of Puducherry, India

Abstract — **Freak accidents are commonly hitting the headlines nowadays due to the moment the driver is careless. Mostly the accidents are common during night time due to the drowsiness of the driver. Adopting this as a major issue we have designed a system to detect the driver's consciousness every moment and guide him or her throughout the journey. The proposed system is wireless and have been implemented with the help of an embedded processor. Our system picks up the brain signal of the driver every moment and transmitted through wireless transmitter module. In the receiver the signals are compared with different signals already stored in it. According to various threshold level programmed the vehicle is guided whether to drive fast, slow or to stop running. Application software has been developed with the help of high level graphical programming language (visual basic) to generate the prototype of brain waves. This system brings out an efficient solution for road accidents by early detection and alarm method.**

Keywords – 8059 controller, brain waves, RF transmitter, RF receiver.

I. INTRODUCTION

For years, the trusty seat belt provided passive restraint in our cars. There were debates about their safety, especially relating to children .Like seat belts, the concept of the airbag a soft pillow to land against in a crash has been around for many years. The first Patent on an inflatable crash-landing device for Air planes was filed during World War II. In the 1980s, the first commercial airbags appeared in automobiles. Since model year 1998, all new cars sold in the United States have been required to have airbags on both driver and passenger sides. Light trucks came under the rule in 1999 Up to date, statistics show that airbags reduce the risk of dying in a direct frontal crash by about 30 percent. Seat-mounted and door-mounted side airbags. Today, some cars have six or even eight airbags.

Cars have changed to be an immaterial one in our day to day life, so as accidents too. Seat belt laws are, ostensibly, for people's benefit. Really, though, they exist for the sake of insurance companies. It's about money. But had they been wearing seatbelts they would have been dead. simple physics will tell you that traveling 50m (flying through a windscreen) before hitting something will result in less force on impact than something that stops you about 5cm from where you started add to that the fact that the belt goes just below your neck, meaning your head (and therefore your spine) continue at full speed until jerking to a sudden stop.

Seat belts don't save lives, they save money. If you crash at a low speed it will prevent you getting a bump on your head, but if you crash on the open road it will snap your neck and kill you instantly, avoiding all those costly rehabilitations you spoke about. Having evoked some of the same controversy that surrounded seat-belt use in its early years, airbags are the subject of serious government and industry research and tests. By using these technologies reduction of accident have been achieved. Yet accidents occur rapidly. This is mainly due to car driver carelessness.

Thus to overcome the above mentioned problem we had introduced a new technology .Here we use brain wave stimulator which controls the car by detecting the brain wave signals like alpha waves are one type of brain waves predominantly originate from the occipital lobe during wakeful relaxation with closed eyes. Alpha waves are reduced with open eyes, drowsiness and sleep. Beta wave, or beta rhythm, is the term used to designate the frequency range of human brain activity between 12 and 30 Hz (12 to 30 transitions or cycles per second). Beta waves are split into three sections: High Beta Waves (19 Hz+); Beta Waves (15–18 Hz); and Low Beta Waves (12–15 Hz). Beta states are the states associated with normal waking consciousness. A gamma wave is a pattern of neural oscillation in humans with a frequency between 25 to 100 Hz though 40 Hz is prototypical and according to the drivers brain activity we can control the vehicle. This causes a remedial change in the accident prevention system.

II. SYSTEM ARCHITECURE

The basic scheme of the proposed EEG-based wireless brain wave system is shown in Figure 1. The hardware of this system consists mainly of two major parts: a wireless physiological signal acquisition module and an embedded signal processing module. First, EEG signal was obtained by EEG electrode, and then was amplified and filtered by EEG amplifier and acquisition unit in the physiological acquisition module. Next, EEG signal was pre-processed by microprocessor unit and transmitted to the embedded signal processing module wirelessly via wireless transmission unit. After receiving EEG signal, it would be monitored and analyzed by our drowsiness detection algorithm implemented in embedded signal processing unit. If the drowsiness condition was detected, warning tone device unit would be triggered to alarm the driver.

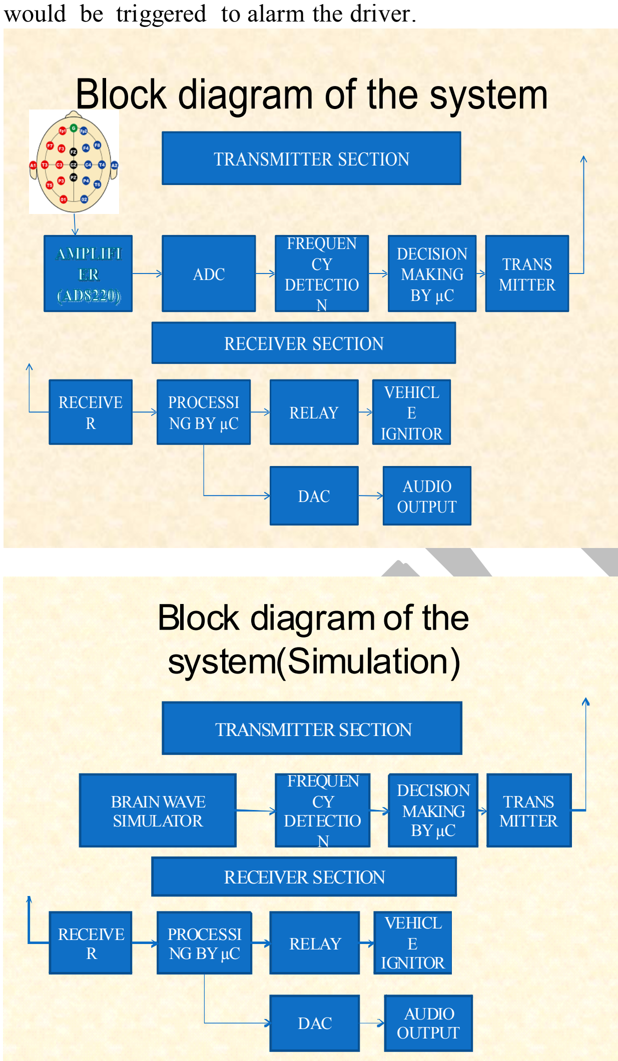
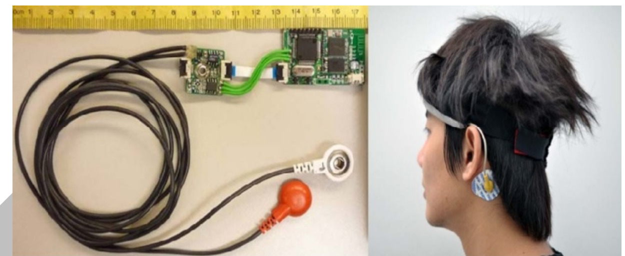


Figure 1. EEG-based wireless brain wave system

A. *Wireless physiological signal Acquisition Module*

The wireless physiological signal acquisition module mainly consists of EEG amplifier and acquisition unit, microprocessor unit and wireless transmission unit. Here, EEG amplifier and acquisition unit, which includes a pre-amplifier, a band-pass filter and a 12-bits analog-to-digital converter (ADC) with sampling rate of 512 Hz, was designed to amplify and filter EEG signal. The gain of EEG amplifier and acquisition unit was set to about 5040 times with the frequency band of 0.1 - 100 Hz. Microprocessor unit was used to control the ADC to obtain, pre-process and send EEG data to wireless transmission unit. In this study, RF module is used in wireless transmission unit. The size of the wireless physiological signal acquisition module is 4 cm × 2.5 cm × 0.6 cm, and can be embedded into a headband as a wearable device, as shown in Figure. 2. This module was designed to operate at 31 mA with 3.7-V DC power supply, and can continuously operate over 33 hours with a commercial 11000 mA Li-ion battery.

Figure 2. Our proposed wireless Physiological Signal Acquisition Module



B. *Embedded Signal Processing Module*

The embedded signal processing module which owns powerful computations and supports various peripheral interfaces was designed as a platform which perform real-time EEG-based wireless brain wave detection algorithm. The embedded module mainly consists of embedded signal processing unit, wireless transmission unit, and warning tone device unit. After receiving EEG data from the wireless brain wave unit, the embedded signal processing unit would analyze the data and display EEG data. If the drowsiness condition was detected, the warning tone device unit would be triggered to alarm the driver. This is show in figure 1.

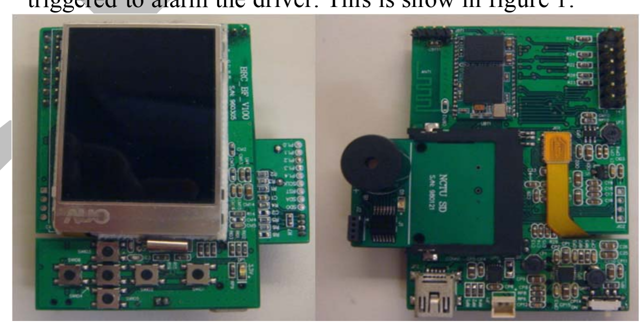


Figure 3. Our proposed Embedded Signal Processing ModuleEquations

C. *Drowsiness Detection Algorithm*

First microcontroller, which also possess switches, generates the wave forms .On switching on a switch respective waveform should be generated. And it is given to the second microcontroller. Frequency detection is done by the second microcontroller. And the same microcontroller performs the decision making process and transmits the decision made to the receiver. Receiver microcontroller on the basis of the received instruction controls the motor or lamp as the case may be. A relay should be incorporated in this section which should not allow the motor to run in the case of receiving the signal obtained from drunk and drive waveforms.

III. RESULTS

In this study, a lane-keeping driving experiment was utilized to investigate driving performance under different levels of drowsiness. Here, a virtual reality (VR)-based cruising environment was developed to simulate a car driving at 100 km/hr on a straight four-lane highway at night, as shown in Fig. 6. The driver is asked to maintain the car along the center of the cruising lane. When the subject is alert, his response time to the random drift is short and the deviation of the car from the center of the lane is small. When the subject is drowsy, both the response time and the car's deviation are high. Therefore, the car's deviation from the central line was used as a measure of the subject's drowsiness state.

Brain wave	Frequency	Associated tasks and behaviors	Distribution
Delta	0.1 to 3 Hz	deep, dreamless sleep, non-REM sleep, trance, unconscious.	generally broad or diffused may be bilateral, widespread
Theta	4-8 Hz	imagery, creative, dreamlike, switching thoughts, drowsy.	usually regional, may involve many lobes, can be lateralized or diffuse
Alpha	8-12 Hz	relaxed, not agitated, but not drowsy, tranquil, conscious	occipitally
Low Beta	12-15 Hz	relaxed yet focused, integrated	frontal, occipital
Mid range Beta	15-18 Hz	thinking, aware of self & surroundings	frontal, occipital
High Beta	above 18 Hz	alertness, agitation	occipital
Gamma	40 Hz	thinking; integrated thoughts	very localized

Figure 4. Different states of brain waves

Figure 5. Virtual reality-based cruising environment in lane-keeping driving experiment

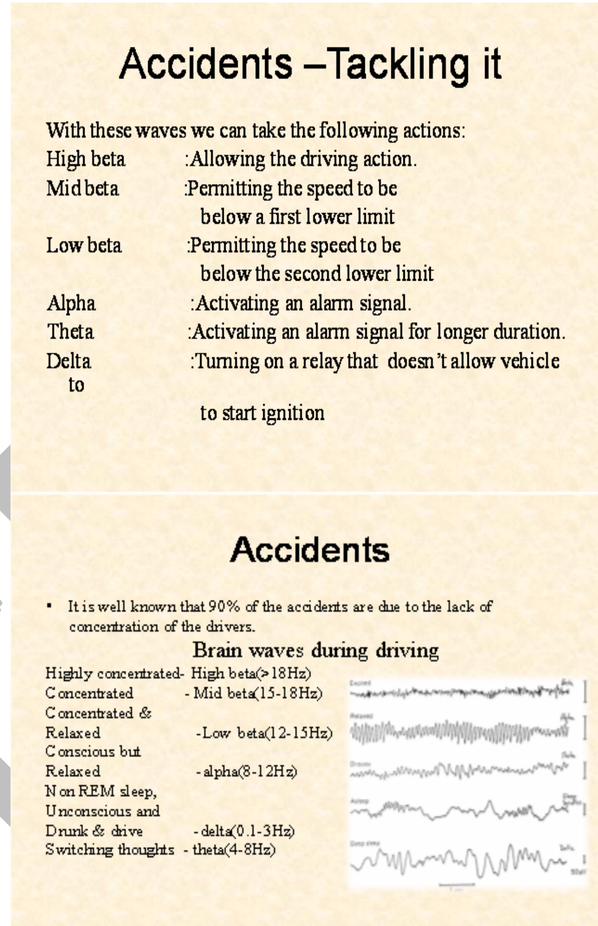


Figure 6. Relationship between driving performance

Figure 6 showed the relationship between driving performance (drowsiness state) and Mahalanobis distance for Alpha rhythm (MDA) and for Theta rhythm (MDT). Obviously, it showed that the driver's drowsiness state was highly correlated to MDA and MDT. Next, the correlation between drowsiness state and MDA, MDT and MDC was investigated. The result was showed above. Here, five subjects were examined. We found that MDC (0.9*MDA+ 0.1*MDT) has higher correlation with drowsiness state. In this investigation, we have demonstrated the feasibility of an unsupervised subject and session independent approach to detect departure from alertness in driver. In future, we plan to identify thresholds on MDA/MDT/MDC which can be used to label the driver's cognitive state as alert/mild drowsy/deep drowsy. This will require some validation data as well as authentication by experts.

IV. DISCUSSIONS AND CONCLUSIONS

In this study, a real-time wireless brain wave stimulated interface for drowsiness detection was proposed. The modular approach applied in hardware and software design enables this system to be configurable for different application scenarios. For example, in the future, the EEG acquisition module can be used to connect several optional physiological sensors in addition to the built-in one, and it doesn't affect the whole system architecture. This system is feasible for further extension.

Moreover, our EEG acquisition module is small, light, and wearable, therefore, it is suitable for long-term EEG monitoring in users' daily life. A novel algorithm for drowsiness detection was also proposed in this study. It can effectively reduce computation complexity, and is suitable to be implemented in the embedded module. This algorithm was validated statistically and then used to assess cognitive state for different subjects effectively. EEG signal would be monitored and analyzed by the embedded signal processing module, and the warning tone would be triggered to prevent traffic accidents when the drowsiness condition occurred.

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